CERTIFICATE OF TRANSLATION

I Roger P. Lewis, whose address is 42 Bird Street North, Martinsburg WV 25401, declare and state the following:

I am well acquainted with the English and Japanese languages and have in the past translated numerous English/Japanese documents of legal and/or technical content.

I hereby certify that the Japanese translation of the attached translation of documents identified as:

JP 2002-271963
"Stereoscopic Microscope"

is to the best of my knowledge and ability true and accurate.

I further declare that all statements contained herein of our own knowledge, are true, that all statements of information and belief are believed to be true.

ROGER P. LEWIS

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Document Specification

Title of Invention Stereoscopic Microscope

Scope of Claims

Claim 1

A stereoscopic microscope, comprising: respectfully and individually, a first connector for connecting a first observation device used by the first observer and a second connector for connecting a second observation device to be used by a second observer in a stereoscopic microscope body housing an objective optical system and a pair of zooming optical systems so that at least two observers, a first observer and a second observer, can observe the same microscope observation image of an observed object at the same time; wherein a stereoscopic microscope comprises the first connector being arranged in the same or lower position relative to the second connector, and the second observation device is connected with the ability to centrally revolve around a rotation axis at the second connector, and the angle made by the rotation axis and the optical axis of the objective optical system between the observed object and the microscope body is 15° or below.

Claim 2

A stereoscopic microscope according to Claim 1, wherein the luminous fluxes of a pair of zooming optical systems are split and are emitted as a total of four luminous fluxes from the second connector towards the second observation device, and the second observation device takes in two luminous fluxes from among the four luminous fluxes and the luminous fluxes that are taken in are switched by way of the revolution.

Claim 3

A stereoscopic microscope according to Claim 2, wherein the two luminous fluxes from among the four luminous fluxes are obtained by splitting into two the luminous flux of either one of the zooming optical system from the pair of zooming optical systems by a pupil splitting means in the vicinity of the exit pupil position of the zooming optical system.

Claim 4

A stereoscopic microscope according to Claim 2, wherein the connecting plane with the first observation device of the first connector is tilted to the first observer side and the second connector is arranged near the opposite side of the first connector as viewed from the first observer side.

Claim 5

A stereoscopic microscope according to Claim 2, wherein the four luminous fluxes are emitted towards the second observation device after being reflected an even number of times by a plurality of optical path deflection reflecting optical elements inside the microscope body.

Claim 6

A stereoscopic microscope according to Claim 2, wherein the second observation device has at least one rotation component in addition to the rotation at the rotation axis, and where the angle made by the rotation axis of the rotation component and the axis of the objective optical system between the observation object and the microscope body is within the range of 35° to 55°, and where all four luminous fluxes that enter into the second observation device arrive at the rotation component, and the rotation component takes in two of the luminous fluxes from among the four luminous fluxes and the luminous fluxes that are taken in are switched by way of the rotation component.

Claim 7

A stereoscopic microscope according to Claim 6, wherein the four luminous fluxes arrive at the rotation component after being reflected an even number of times by the optical path deflection reflecting optical elements.

Claim 8

A stereoscopic microscope according to Claim 2, wherein the second observation device is comprised of an intermediate lens barrel that houses a pair of relay optical systems and a single image rotator, as well as an eyepiece lens barrel that houses a pair of image formation optical systems and a pair of eyepiece optical systems; and the intermediate lens barrel connects with the second connector at the entry side of the light beam then connects at the exit side of the light beam with the eyepiece lens barrel with the ability to revolve, and both luminous fluxes of the pair of relay optical systems housed in the intermediate lens barrel transmit through the image rotator at the same time where the image rotator rotates them in turn at 1/2 angle in relation to the rotation of the eyepiece lens barrel.

Claim 9

A stereoscopic microscope according to Claim 2, wherein the second observation device is comprised of an intermediate lens barrel that houses a pair of relay optical systems and a single image rotator, as well as an eyepiece lens barrel that houses a pair of image formation optical systems and a pair of eyepiece optical systems; and the intermediate lens barrel connects with the second connector at the entry side of the light beam then connects at the exit side of the light beam with the eyepiece lens barrel, and the eyepiece lens barrel has the ability to expand and contact in the exit optical axis direction of the pair of relay optical systems housed by the intermediate lens barrel, and both of the exit pupil positions of the pair of relay optical systems housed by the intermediate lens barrel are arranged near the middle position within the range of the expansion and contraction movement.

Detailed Description of the Invention

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Technical Field Relating to the Invention

The present invention relates to a stereoscopic microscope such as a surgical microscope that has the ability for a plurality of observers to observe the same microscope observation image of an observation object at the same time.

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Prior Art

Stereoscopic microscopes such as those used for surgical microscopes of the prior art provide surgeons a magnified view of the surgical area used in surgical operations by neurosurgeons, otolaryngologists, as well as ophthalmologists and provide a critical function to improve the efficacy of the surgery.

0003

Today, so called micro surgery, which uses a microscope for surgery, is advanced and precise and is designed to approach the surgical area from various directions, and surgery is performed under the observation of two persons, an observer who has primary responsibility for the surgery (hereafter referred to as the first observer) and an observer who has the responsibility of supporting the first observer (the second observer) in order to improve the safety of the operation.

0004

Surgical microscopes of the prior art are limited to angles of 180° or 90° when two observers peer through a surgical microscope. For example, as seen in Fig. 17, there is a problem that only one observer is able to observe depending on the approach direction to the surgical area (fore example see patent reference documents 1 and 2). Fig. 17 (b) shows an example of the first

observer 1 and the second observer 2 observing by facing each other at an angle of 180° approaching the surgical area 4 from directly above using the surgical microscope 3. Fig. 17 (b) also shows an example where although the first observer 7 is able to observe by approaching the surgical area 6 at an angle from the direction of the first observer with the surgical microscope 5 that enables two observers to face each other at an angle of 180°, since the surgical microscope 5 is tilting the second observer is unable to observe.

0005

Moreover, the "angle for two observers to peer into a surgical microscope" as described above and as is indicated in Fig. 1, can be expressed as the angle α which is made by the direction of the body of the first observer 32 peering into the first observation device 31 and the direction of the body of the second observer 33 peering into the second observation device not shown.

0006

On the other hand, with a different surgical microscope of the prior art, the above problem is resolved by making the angle to be variable for two observers to peer into a surgical microscope (see reference documentation 3 for example). However, with this surgical microscope, as shown in Fig. 18, since an optical path splitting means 11 is housed between the objective optical system 9 and the first observation device 10 used by the first observer, the microscope increases in size and the distance between the bottom surface 12 of the surgical microscope and the eyepiece lens 13 becomes long thereby making the distance from the surgical area 14 to the bottom surface 12 f the surgical microscope to be shortened which narrows the work space directly below the surgical microscope.

0007

In addition, since the second observation device 15 for providing the observation image to the second observer is arranged directly below the first observation device 10, the space 19 located below eye level 18 which is the height of the eyes of the observer in front of the first observer 17

who is observing through the surgical microscope 16 shown in Fig. 19 and the space 21 near the lateral vicinity of the surgical microscope main body 20 shown in Fig. 20, are both narrowed by the second observation device 22 for providing the observation image to the second observer. When narrowing the space near the surgical microscope lower than eye level of an observer and the work space directly below a surgical microscope in such a manner, there is the problem that the treatment tool 24 held by the first observer 23 comes in contact with the second observation device causing an inconvenience to the surgery.

0008

Reference Documentation 1: Patent Publication Sho47-41473 (Fig. 1)

0009

Reference Documentation 2: Patent Publication Sho55-39364 (Figs. 2 through 4)

0010

Reference Documentation 3: Laid-Open Patent Publication Hei10-5244 (Fig. 1)

0011

Problems Overcome by the Invention

The present invention has considered the problems described above with the conventional technology and has as its objective to provide an easy to use surgical microscope for use by two observers that has the ability to make the angle for peering into a surgical microscope for use by two observers variable according to the direction approaching a surgical area and which does not narrow the working space of the surgery by way of the second observation device.

0012

Problem Resolution Means

The stereoscopic microscope of the present invention:

1) Comprising respectfully and individually, a first connector for connecting a first observation device used by the first observer and a second connector for connecting a second observation device to be used by a second observer in a stereoscopic microscope body housing an objective optical system and a pair of zooming optical systems so that at least two observers a first observer and a second observer can observe the same microscope observation image of an observed object at the same time; a stereoscopic microscope comprises the first connector is arranged in the same or lower position relative to the second connector, and the second observation device is connected with the ability to centrally revolve around a rotation axis at the second connector, and the angle made by the rotation axis and the optical axis of the objective optical system between the observed object and the microscope body is 15° or below.

0013

According to this construction, the angle for a first observer and a second observer to peer into a stereoscopic microscope can be made to be variable, and since the second observation device is not arranged lower than the first observation device the problem of narrowing the required working space for surgery does not occur as in the prior art.

0014

Furthermore, it is preferred that the rotation axis of the second observation device and the axis of the objective optical system between the observation object and the main body of the stereoscopic microscope be parallel.

2) Wherein the luminous fluxes of a pair of zooming optical systems are split and are emitted as a total of four luminous fluxes from the second connector towards the second observation device,

and the second observation device takes in two luminous fluxes from among the four luminous fluxes and the luminous fluxes that are taken in are switched by way of the revolution.

0015

Fig. 1 will be used to describe an outline of the stereoscopic microscope according to this construction. Fig. 1 is an outline construction drawing viewed from above the stereoscopic microscope. The four luminous fluxes 27, 28, 29, and 30 from within the second connector 26 arranged on the top of the stereoscopic microscope main body 25 exit facing the second observation device not shown. From among these four luminous fluxes, the two luminous fluxes 29 and 30 that do not have a diagonal line are the luminous fluxes that provide the microscope image in the correct image orientation to the second observers 33 and 34 peering into the microscope at an angle of 90° laterally in relation to the first observer 32 who is observing through the first observation device 31. Meanwhile, the two luminous fluxes 27 and 28 that do have a diagonal line are the luminous fluxes that provide the microscope image in the correct image orientation to the second observer 35 who is peering through the microscope at an angle of 180° in relation to the first observer who is observing through the first observation device 31.

0016

Here, the provided microscope image being in the "correct image orientation" means that the orientation of the observation image of the surgical area seen through the microscope by the second observer and the orientation of the surgical area seen directly from the standing position of the second observer match.

0017

Further, the second observation device has a constitution for taking in two luminous fluxes from among the four luminous fluxes that enter, and is constructed for switching the luminous fluxes so as to enable microscope observation with the correct image orientation in that position by rotating the second observation device according to the standing position of the second observer.

According to this construction, it is possible for the second observer, by rotating the second observation device, to always observe the correct image orientation even when observing from any direction of 90° left or 90° right or at 180° in relation to the first observer.

(3) Wherein the two luminous fluxes from among the four luminous fluxes are obtained by splitting into two the luminous flux of either one of the zooming optical system from the pair of zooming optical systems by a pupil splitting means in the vicinity of the exit pupil position of the zooming optical system.

0018

According to this construction, a small scale composition of the stereoscopic microscope main body can be achieved in order to obtain four luminous fluxes that exit facing to the second observation device without requiring four zooming optical systems. Moreover, the position for splitting the luminous fluxes by the pupil splitting means can be near to exit pupil position of the zooming optical system that is relayed to a different position by the relay optical system or so forth.

(4) Wherein the connecting plane with the first observation device of the first connector is tilted to the first observer side and the second connector is arranged near the opposite side of the first connector as viewed from the first observer side.

0019

According to this construction, as shown in Fig. 2 (a), because the first connector 36 that is connected by the first observation device for sue by the first observer 37 is slanted to the first observer 37 side, the second connector 38 that is connected by the second observation device 42 for use by the second observer 38 can be arranged closer to the first connector 36, and when the first observer 37 and the second observer 38 use the stereoscopic microscope facing each other, the distance 40 between the surgical area which is the observation object and the second observer can be maintained close. For this reason, as is shown by the example in Fig. 2 (b), by separating

the first connector 45 that is connected by the first observation device for use by the first observer from the second connector 48 that is connected by the second observation device 47 for use by the second observer 46, the distance 50 between the surgical area which is the observation object and the second observer gets farther hampering the workability as it becomes more difficult for the second observer 46 to reach the surgical area.

(5) Wherein the four luminous fluxes are emitted towards the second observation device after being reflected an even number of times by a plurality of optical path deflection reflecting optical elements inside the microscope body.

0020

According to this construction, as shown in Fig. 3, the second observer observing by using the second observation device can always execute microscope observation with the correct image orientation even if the second observation device is rotated by the range taking in the two luminous fluxes 51 and 52 from among the four luminous fluxes with the two optical system openings 54 and 55 of the second observation device 53.

(6) Wherein the second observation device has at least one rotation component in addition to the rotation at the rotation axis, and where the angle made by the rotation axis of the rotation component and the axis of the objective optical system between the observation object and the microscope body is within the range of 35° to 55°, and where all four luminous fluxes that enter into the second observation device reach the rotation component, and the rotation component takes in two of the luminous fluxes from among the four luminous fluxes and the luminous fluxes that are taken in are switched by way of the rotation component.

0021

According to this construction, the angle for two observers of a first observer and a second observer for peering into a stereoscopic microscope has the ability to be variable.

(7) Wherein the four luminous fluxes reach the rotation component after being reflected an even number of times by the optical path deflection reflecting optical elements.

0022

According to this construction, the same efficacy can be obtained as that described in item (2) above by rotating the rotation component of the second observation device.

(8) Wherein the second observation device is comprised of an intermediate lens barrel that houses a pair of relay optical systems and a single image rotator, as well as an eyepiece lens barrel that houses a pair of image formation optical systems and a pair of eyepiece optical systems; and the intermediate lens barrel connects with the second connector at the entry side of the light beam then connects at the exit side of the light beam with the eyepiece lens barrel with the ability to revolve, and both luminous fluxes of the pair of relay optical systems housed in the intermediate lens barrel transmit through the image rotator at the same time where the image rotator rotates them in turn at 1/2 angle in relation to the rotation of the eyepiece lens barrel.

0023

According to this construction, the image rotator for sequential rotation at a ½ ratio to the rotating eyepiece lens barrel matches at all times, without regard to the rotation of the eyepiece lens barrel, the exit pupil of the pair of relay optical systems that transmit through the image rotator, with both incident pupils of the pair of image formation optical systems that move in conjunction to the rotation of the eyepiece lens barrel. For this reason, it becomes possible to obtain an observation image with no eclipse even when the second observer rotates the eyepiece lens barrel and microscope observation can be executed with a more favorable situation.

(9) Wherein the second observation device is comprised of an intermediate lens barrel that houses a pair of relay optical systems and a single image rotator, as well as an eyepiece lens barrel that houses a pair of image formation optical systems and a pair of eyepiece optical systems; and the intermediate lens barrel connects with the second connector at the entry side of

the light beam then connects at the exit side of the light beam with the eyepiece lens barrel, and the eyepiece lens barrel has the ability to expand and contact in the exit optical axis direction of the pair of relay optical systems housed by the intermediate lens barrel, and both of the exit pupil positions of the pair of relay optical systems housed by the intermediate lens barrel are arranged near an interim position within the range of the expansion and contraction movement.

0024

According to this construction, the second observer can move the position of the eyepiece lens barrel within the range of expansion and contraction movement in the direction of the exit optical axis of the pair of relay optical systems housed in the intermediate lens barrel enabling the use of a microscope in a freer position. Further, since the exit pupil position of the pair of relay optical systems are arranged near to the middle position of the expansion and contraction range, and since the pair of image formation optical systems housed by the eyepiece lens barrel take in the luminous fluxes in a state of very little eclipse when output by the pair of relay optical systems housed by the intermediate lens barrel, even if the second observer moves the eyepiece lens barrel to any position a microscope image with no eclipse can be observed.

0025

Embodiment

A description of the Embodiment for the stereoscopic microscope of the present invention will be provided hereafter with reference to Drawings.

Embodiment 1

Fig. 4 and Fig. 5 are summary drawings of the stereoscopic microscope that relates to the present Embodiment. As shown in Fig. 4, the first connector 57 that is connected by the first observation device 56 and the second connector 59 that is connected by the second observation device 58 being on top of the microscope body 60 of the stereoscopic microscope supported by the support

component 200 and being respectively in separate positions on the microscope body 60 with the first connector being arranged lower and closer to the observation object 61 than the second connector.

0026

Further, as shown in Fig. 5, the second observation device 63 is connected to the second connector 62 with the ability to revolve, and the rotation axis 64 of the second observation device 63 and optical axis 67 of the objective optical system from the observation object 65 to the microscope body 66 is constructed so as to be parallel.

0027

According to this construction, as seen in Fig. 5, the second observer 68 observing a microscope observation image by using the second observation device 63 has the ability to observe the microscope image in various angles in relation to the first observer 70 who is observing the microscope observation image by using the first observation device 69.

0028

Also, since the second observation device 63 is arranged to the lower side of the first observation device 69, the distance from the eyepiece 73 of the first observation device to the bottom surface 74 of the microscope body 66 can be shortened, and by maintaining a long distance from the observation object 65 to the bottom surface 74 of the microscope body, there is no narrowing of the working space directly below the stereoscopic microscope.

0029

In addition, the space 75 near the lateral vicinity of the microscope body 66 below eye level 71 of the observer and in front of the first observer 70 is not narrowed by the second observation device 63.

The stereoscopic microscope of the present Embodiment as described above has the ability to provide work to be safely performed under microscope observation by an observer while maintaining a wide space required to work on an operation while also providing a variable angle for two observers to peer into a stereoscopic microscope.

Embodiment 2

First, the construction of the microscope body of the stereoscopic microscope of the present Embodiment will be explained using Fig. 6. Fig. 6 is an outline drawing of the stereoscopic microscope of the present Embodiment. A first connector 79 for connecting the first observation device 78 for use by the first observer 77 and a second connector 81 for connecting the second observation device 80 with the ability to revolve for use by the second observer not shown is arranged. Further, the first connector 79 is arranged at a tilt to the first observer 77, and the second connector 81 is arranged near to the opposite side of the first connector 79 as seen from the first observer 77 side. In addition, the luminous fluxes 82, 83, 84, and 85 are exited from within the second connector 81 facing to the second observation device 80.

0030

Next, a description will be given using Fig. 7. Fig. 7 illustrates the optical arrangement inside the stereoscopic microscope main body described in Fig. 6. After the luminous fluxes emitted from the observation object 86 pass through the objective optical system 87 and are deflected by the optical path deflection reflecting element 88, and become the two luminous fluxes by passing through the pair of zooming optical systems 89, it is relayed by the front lens group 90, a pair of first relay optical systems comprised of a prism being the optical path deflection reflecting element, and a rear lens group 91 and it is emitted from the first connector 93 facing to the first observation device not shown.

0031

Further, the luminous fluxes 94 and 94 exiting the first relay optical systems are split by the beam splitter 96 which is the optical path splitting means that is arranged directly below the second connector 95, and the two split luminous fluxes 97 and 98 are exited from the second connector 95 facing to the second observation device not shown.

0032

In addition, the one luminous flux from the pair of luminous fluxes that pass through the pair of first relay optical systems are split by the beam splitter 99 that is arranged in the optical path within the first relay optical system. The one luminous flux 100 subsequent to splitting is guided to the pupil splitting prism 101 which is the pupil splitting means by way of a plurality of prisms, and it becomes two luminous fluxes 104 and 104 by being split. The pupil splitting prism 101 is arranged near to the position where the exit pupil with be relayed by the first relay optical system. Further, the two split luminous fluxes 104 and 104 are further relayed by the second relay optical system comprised of a front lens group 102, a rear lens group 103 as well as prisms and mirrors, and become two luminous fluxes 105 and 106 that are exited from the second connector 95 facing to the second observation device not shown. Accordingly, the luminous fluxes exited from the second connector 95 become a total of four luminous fluxes.

0033

The two luminous fluxes 105 and 106 from among these four luminous fluxes are the luminous fluxes that provide the microscope image in the correct image orientation to the second observer peering into the microscope at a lateral 90° angle in relation to the first observer who is observing through the first observation device not shown, and the remaining two luminous fluxes are the luminous fluxes that provide the microscope image in the correct image orientation to the second observer peering into the microscope at a 180° angle in relation to the first observer who is observing through the first observation device not shown.

0034

In addition, all four luminous fluxes 97, 98, 105, and 106 exit from the second connector 95 after being reflected an even umber of times by a plurality of prisms and mirrors within the stereoscopic microscope main body. Moreover, with the description given using Fig. 6 and Fig. 7 above, the optical axis in the drawings are expressed as luminous fluxes.

0035

According to the construction of the stereoscopic microscope main body described above, the distance between the surgical area which is the observation object and the second observer can be maintained short when a first observer and a second observer use a stereoscopic microscope facing each other. For this reason, it is possible to improve the workability of the second observer. Furthermore, since four luminous fluxes are obtained after exiting facing to the second observation device, a small scale composition is made possible for a stereoscopic microscope main body without requiring four zooming optical systems.

0036

Next, a description will be given mainly of the second observation device of the stereoscopic microscope of the present Embodiment using Fig. 8. Fig. 8 is an outline drawing of the second observation device that connects to the second connector of the microscope body of a stereoscopic microscope. The second observation device 107 is comprised of an intermediate lens barrel 108 and an eyepiece lens barrel 109, and the intermediate lens barrel 108 connects to the eyepiece lens barrel 109 with the ability to revolve. Further, the intermediate lens barrel 108 houses a single image rotator and a pair of relay optical systems inside.

0037

Fig. 9 (a) shows a lateral view drawing of the optical system arrangement of the intermediate lens barrel interior. Fig. 9 (b) shows a top view thereof. Only two luminous fluxes 111 and 112 from among the four luminous fluxes 111, 112, 113, and 114 exiting from the second connector 110 of the microscope body are taken into the pair of relay optical systems composed of prisms

115 and 116, lenses 117 and 118, and the formation optical system 119. Furthermore, when rotating the rotation axis 119 of the second observation device centrally 90°, next the other two luminous fluxes 113 and 114 can be taken in. In this manner, the intermediate lens barrel constituting the second observation device takes in the two luminous fluxes from among the four luminous fluxes that exit from the second connector, and the received luminous fluxes can be switched by the rotation of the second observation device.

0038

In addition, the single image rotator 120 housed within the intermediate lens barrel is arranged so as to transmit simultaneously both luminous fluxes of the pair of relay optical systems, and rotate them in turn at a ratio of 1/2 of the rotation amount of the rotating eyepiece lens barrel 121.

0039

By combining each construction of the second observation device given above and the each construction of the microscope body described above, it becomes possible to always observe in the correct image orientation regardless from which direction observation occurs in the 90° right or the 90° left or the 180° direction in relation to the first observer by rotating the second observation device by the second observer. Furthermore, even if rotating the second observation device within the range where the pair of relay optical systems housed by the intermediate lens barrel takes in the luminous fluxes, the second observer can observe through a microscope with the correct image orientation. Further, depending on the effects of the image rotator, it is possible for the second observer to obtain an observation image with no eclipse regardless of the rotation of the eyepiece lens barrel, thereby increasing the freedom in the observation position of the second observer.

0040

Next, a detailed description will be given of several optical systems given in the constitution above. Fig. 10 is a detail drawing of the second relay optical system explained by Fig. 7. The

lens 124 with a tilted line from among the lenses comprising the front lens group 122 and the lens 125 with a tilted line from among the lenses comprising the rear lens group 123 use anomalous dispersion glass as their glass material and constrain the deterioration of the optical performance to a minimum through the relay optical systems.

0041

Below is a record of the lens data for the second relay optical system.

	Radius of Curvature	Plane Spacing Distance	Glass Refractive Index	Glass Dispersion
Pupil Splitting Position		68.95		
R1	30.762	3.9	1.49	70.2
R2	-30.762	0.2		
R3	70.517	4.0	1.5	81.6
R4	-20.456	1.9	1.7	55.5
R5	102.56	3.2		
R6	-25.62	2.0	1.58	41.5
R7	-55.472	49.51		
Image Formation Plane		60.53		
R8	62.318	2.0	1.64	44.9
R9	24.469	4.6	1.44	95.0
R10	-31.864	70		
Exit Pupil Plane				

Furthermore, the luminous fluxes of the second relay optical systems are split in half by the pupil splitting prism and pass through the center of gravity of the exit pupil of the zooming optical system relayed by the first relay optical system. For this reason, in comparison to the relay optical system 128 through which the optical axis 127 passes the center 126 of the exit pupil prior to splitting as shown in Fig. 11 (a), the relay optical system 131 through which the optical axis 130 passes the center of gravity 129 of the exit pupil subsequent to being split in half as

shown in Fig. 11 (b) can be made to have a smaller lens diameter thereby resulting in the ability to devise a small scale composition to the stereoscopic microscope main body.

0042

In addition, Fig. 12 shows the relay optical system housed by the intermediate lens barrel constituting the second observation device. The lens 134 with a tilted line from among the lenses comprising the front lens group 132 and the lenses 135, 136 and 137 with a tilted line from among the lenses comprising the rear lens group 133 use anomalous dispersion glass as their glass material and constrain the deterioration of the optical performance to a minimum through the relay optical systems.

0043

Below is a record of the lens data for the relay optical system housed by the intermediate lens barrel.

	Radius of Curvature	Plane Spacing Distance	Glass Refractive Index	Glass Dispersion
Prism Incident Plane	∞	49.155	1.51633	64.1
Incident Pupil Position		24.715	1.51633	64.1
Prism Exit Plane	∞	2.5		
R1	71.354	3	1.496999	81.6
R2	-21.547	1.5	1.729157	54.7
R3	∞	0.5		
R4	34.904	1.5	1.6727	32.1
R5	20.807	3	1.517417	52.4
R6	-54.117	11.5		
Mirror Reflecting Plane	∞	6.5		
Prism Incident Plane	∞	12	1.568832	56.3
Prism Exit Plane	∞	21		
Mirror Reflecting Plane	∞	9		
Image Formation Position		5.5		

Mirror Reflecting Plane	∞	5.5		
Prism Incident Plane	∞	41.778	1.568832	56.3
Prism Exit Plane	∞	4.5		
R7	∞	3.8	1.496999	81.6
R8	-17.851	0.2		
R9	71.003	5.2	1.496999	81.6
R10	-14.304	1.8	1.69797	55.5
R11	54.702	3.5		
R12	-16.446	1.9	1.69797	55.5
R13	34.763	5.2	1.496999	81.6
R14	-19.375	0.2		
R15	35.074	3.2	1.785896	44.2
R16	∞	11		
Prism Incident Plane	∞	57.696	1.785896	44.2
Prism Exit Plane	∞	39.17		
Exit Pupil Position				

Embodiment 3

A description of the stereoscopic microscope of the present Embodiment will be given using Fig. 13 and Fig. 14. Fig. 13 is an outline drawing of the second observation device. The second observation device 138 has a single rotation component 140 that rotates centrally the rotation axis 145 making an angle of 50° with the optical axis of the objective optical system between the object and the microscope body other than the connector 139 of the second connector for the microscope body of the stereoscopic microscope, and all four luminous fluxes that enter into the second observation device 138 pass through the optical system housed in the fixed component 142 and arrive at the rotation component 140.

0044

Fig. 14 is a drawing showing the optical system arrangement housed by the second observation device. The fixed component 138 passes all of the four luminous fluxes that enter and houses the prism 139 that deflects the luminous fluxes by the twice reflecting mirror. The rotation

component 140 houses a pair of relay optical systems comprised of a lens 141, a formation optical system 142, a prism 143 and an image rotator 144.

0045

According to this construction, as shown in Fig. 15, the angle α can be made to be variable for two observers of a first observer 148 and a second observer 149 to peer into a stereoscopic microscope by the rotation of the rotation component 147 of the second observation device 146, thereby increasing the degree of freedom for the observation position for the second observer. Furthermore, the second observer can always execute a microscope observation image with the correct image orientation even by rotating the rotation component within the range for taking in the luminous fluxes by the pair of relay optical systems housed within the rotation component of the second observation device.

Embodiment 4

A description of the stereoscopic microscope of the present Embodiment will be given using Fig. 16. Fig. 16 is an outline drawing of the second observation device. The second observation device 150 is composed of an intermediate lens barrel 152 for housing a pair of relay optical systems, and an eyepiece lens barrel 155 for housing a pair of image formation optical systems 153 and a pair of eyepiece optical systems 154.

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In addition, the intermediate lens barrel 152 connects to the second connector 157 of the microscope body 156 of the stereoscopic microscope at the incident side of the light beam, and it connects to the eyepiece lens barrel 155 at the exit side of the light beam. The eyepiece lens barrel 155 has the ability to extend and contract in the direction of the exit optical axis 158 of the pair of relay optical systems 151 housed by the intermediate lens barrel 152. Also, both exit pupil positions 159 of the pair of relay optical systems housed by the intermediate lens barrel 152 are arranged in the middle position within the expansion and contraction movement range.

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According to this construction, the second observer 160 can move the position of the eyepiece lens barrel 155 within the extraction and contraction movement range in the direction of the exit optical axis of the pair of relay optical systems housed by the intermediate lens barrel 152, thereby making it possible for microscope observation to be performed in a freer position. In addition, since the exit pupil positions 159 of the pair of relay optical systems are arranged near to the middle position of the expansion and contraction movement range, and because the pair of image formation optical systems housed by the eyepiece lens barrel take in the luminous fluxes, which exit the pair of relay optical systems housed by the intermediate lens barrel, in a state of slight eclipse, the second observer can observe a microscope image with no eclipse by moving the eyepiece lens barrel to any position.

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Efficacy of the Invention

The present invention has the ability to provide a surgical microscope with favorable workability for use by two observers which does not narrow the work space of the surgery by way of the second observation device and which has the ability to make the angle for two observers to peer into a surgical microscope to be variable according to the approaching direction to the surgical area.

Brief Description of the Drawings

Fig. 1 is a top view drawing of the stereoscopic microscope of the present invention.
Fig. 2 is a lateral view drawing of the stereoscopic microscope of the present invention.
Fig. 3 is a drawing showing the rotation of the second observation device of the stereoscopic microscope of the present invention.
Fig. 4 is an outline angle view of Embodiment 1 of the present invention.

Fig. 5 is an outline angle view of Embodiment 1 of the present invention.

Fig. 6 is an outline angle view of Embodiment 2 of the present invention.

Fig. 7 is a drawing showing the optical system arrangement of Embodiment 2 of the present invention.

Fig. 8 is a drawing showing the second observation device of Embodiment 2 of the present invention.

Fig. 9 is a drawing showing the optical system arrangement of the intermediate lens barrel of Embodiment 2 of the present invention.

Fig. 10 is a detailed drawing of the second relay optical system of Embodiment 2 of the present invention.

Fig. 11 is a drawing showing the construction of the second relay optical system of Embodiment 2 of the present invention.

Fig. 12 is a detailed drawing of the relay optical system housed by the second observation device of Embodiment 2 of the present invention.

Fig. 13 is an outline drawing of the second observation device of Embodiment 3 of the present invention.

Fig. 14 is a drawing showing the optical system arrangement of the second observation device of Embodiment 3 of the present invention.

Fig. 15 is a drawing showing the rotation of the rotation component of the second observation device of Embodiment 3 of the present invention.

Fig. 16 is an outline drawing of the second observation device of Embodiment 4 of the present invention.

Fig. 17 is a drawing showing the state of use of the surgical microscope of the prior art.

Fig. 18 is a cross-sectional drawing of another surgical microscope of the prior art.

Fig. 19 is a drawing showing the work space in another surgical microscope of the prior art.

Fig. 20 is a drawing showing the work space in another surgical microscope of the prior art.

Explanation of the Reference Numerals

25, 60	Microscope body
26, 38, 48, 59	Second connector

27, 28, 29, 30, 51, 52	Luminous flux
31, 41, 44, 56	First observation device
32, 37, 43	First observer
33, 34, 35, 38, 46	Second observer
36, 45, 57	First connector
39, 49	Surgical area
40, 50	Distance between the surgical area and the second observer
42, 47, 53, 58	Second observation device
54, 55	Optical system opening
61	Observation object
200	Support component

[Document Name] Abstract

[Abstract]

[Problem]

To provide a surgical microscope with favorable workability for use by two observers which does not narrow the work space of the surgery by way of the second observation device and which has the ability to make the angle for two observers to peer into a surgical microscope to be variable according to the approaching direction to the surgical area.

[Resolution Means]

A first connector 57 is arranged in the same or lower position in relation with the second connector 59, and the second observation device 58 is connected to the second connector 59 with the ability to rotate centrally around a rotation axis, and the angle made by the rotation axis and the axis of the objective optical system between the observation object 61 and the microscope body 1 is 15° or below.

Selected Drawing Fig. 4

Claim A

Claim 1

A stereoscopic microscope for two observers, a first observer having primary responsibility for a surgery and a second observer having the responsibility of supporting the first observer, can observe the same microscope observation image of an observed object at the same time, comprising:

a first connector installed in the vicinity in relation to the optical axis of an objective optical system for connecting a first observation device used by the first observer to a stereoscopic microscope main body that houses an objective optical system and a pair of zooming optical systems,

a second connector arranged in a position that is equal to or higher in relation to the first connector and which is also installed separated farther than the first connector in relation to the optical axis of the objective optical system for connecting a second observation device to be used by a second observer.

Claim 2

A stereoscopic microscope according to Claim 1, wherein a second observation device is connected to the second connector with the ability to centrally revolve around a rotation axis, and the angle made by the rotation axis and the optical axis of the objective optical system between the observed object and the microscope body is 15° or below.

Claim 3

A stereoscopic microscope according to Claim 2, wherein the second observation device has an optical system for splitting the luminous flux of a pair of zooming optical systems and guiding a total of four luminous fluxes to the second connector, and a construction that takes in two luminous fluxes from among the total of four luminous fluxes and the luminous fluxes that are

taken in are switched with the other luminous fluxes by the central revolution around a rotation axis.

Claim 4

A stereoscopic microscope according to Claim 3, wherein a pupil splitting means splits a luminous flux in two near to the exit pupil position of one zooming optical system of either of the pair of zooming optical systems.

Claim 5

A stereoscopic microscope according to Claim 1, wherein a first connector is arranged so that the connection plane with the first observation device is tilting to the first observer side, and a second connector is arranged to the opposite side of the first connector as seen from the first observer side.

Claim 6

A stereoscopic microscope according to Claim 3, wherein an optical system includes a plurality of optical path deflection reflecting optical elements that lead the four luminous fluxes to the second connector after each being reflected an even number of times.

Claim 7

A stereoscopic microscope according to Claim 3, wherein there is at least one location for revolution other than the revolution at the second connector, and that angle made by such rotation axis and the axis of the objective optical system between the observation object and the microscope body is within the range of 35° to 55°, and the second observation device has an optical system for guiding to the rotation component all four luminous fluxes that have been guided to the second connector, and it has a construction that takes in two luminous fluxes from

among the total of four luminous fluxes and the luminous fluxes that are taken in are switched with the other luminous fluxes by the central revolution around a rotation axis.

Claim 8

A stereoscopic microscope according to Claim 7, wherein an optical system includes an optical path deflection reflecting optical element that leads the four luminous fluxes to the rotation component after each being reflected an even number of times.

Claim 9

A stereoscopic microscope according to Claim 3, wherein a second observation device provides an intermediate lens barrel housing a pair of relay optical systems and a single image rotator, and an eyepiece lens barrel housing a pair of image formation optical systems and a pair of eyepiece optical systems, and the intermediate lens barrel connects to the second connector at the incident side of the light beam and it connects to the eyepiece lens barrel at the exit side of the light beam with the ability to revolve, and both luminous fluxes of the pair of relay optical systems housed by the intermediate lens barrel transmit through the image rotator at the same time, and the image rotator rotates sequentially at 1/2 the angle in relation to the rotation of the eye piece lens barrel.

Claim 10

A stereoscopic microscope according to Claim 3, wherein a second observation device provides an intermediate lens barrel housing a pair of relay optical systems and a single image rotator, and an eyepiece lens barrel housing a pair of image formation optical systems and a pair of eyepiece optical systems, and the intermediate lens barrel connects to the second connector at the incident side of the light beam and it connects to the eyepiece lens barrel at the exit side of the light beam, and the eyepiece lens barrel has the ability to expand and contract in the direction of the exit optical axis of the pair of relay optical systems housed by the intermediate lens barrel, and the

exit pupil position of the pair of relay optical systems are arranged near the vicinity of the middle position within the expansion and contraction movement range.

Claim 11

An observation device used by attaching to the body of a stereoscopic microscope, wherein it provides an intermediate lens barrel housing a pair of relay optical systems and a single image rotator, and an eyepiece lens barrel housing a pair of image formation optical systems and a pair of eyepiece optical systems, and the intermediate lens barrel connects to the second connector at the incident side of the light beam and it connects to the eyepiece lens barrel at the exit side of the light beam with the ability to revolve, and both luminous fluxes of the pair of relay optical systems housed by the intermediate lens barrel transmit through the image rotator at the same time, and the image rotator rotates sequentially at 1/2 the angle in relation to the rotation of the eye piece lens barrel.

Claim 12

An observation device used by attaching to the body of a stereoscopic microscope, wherein it provides an intermediate lens barrel housing a pair of relay optical systems and a single image rotator, and an eyepiece lens barrel housing a pair of image formation optical systems and a pair of eyepiece optical systems, and the intermediate lens barrel connects to the second connector at the incident side of the light beam and it connects to the eyepiece lens barrel at the exit side of the light beam, and the eyepiece lens barrel has the ability to expand and contract in the direction of the exit optical axis of the pair of relay optical systems housed by the intermediate lens barrel, and the exit pupil position of the pair of relay optical systems are arranged near the vicinity of the middle position within the expansion and contraction movement range.